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MINUTES
OF THE TENTH
EXPLOSIVES SAFETY SEMINAR

SHERATON HOTEL
Louisville, Kentucky
13-15 August 1968

VOLUME II

Sponsor

ARMED SERVICES EXPLOSIVES SAFETY BOARD
Washington, D. C. 20315

Host

U.S. ARMY MATERIEL COMMAND FIELD SAFETY AGENCY
Charlestown, Indiana

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THE US ARMY CB WEAPONS SURETY PROGRAM

by

John L. Chamberlin
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Army Materiel Command

Thank you, Colonel Abrams. When I saw the agenda for this meeting, I was a little concerned because this was labeled a technical presentation, and my paper is actually on a management topic. I trust, however, that it will serve as an opening note on the high importance of explosive safety today.

I think that it is significant to consider that, not too many years ago, explosive safety was hardly a matter of general concern, and was happily left to a few experts, or to people who were unlucky enough to live next to an ammunition plant. Today, with weapons of mass destruction on everyone's mind, and, in a sense, on everyone's doorstep, you find yourselves in a business which is very much a public concern.

It is this new condition of public and Governmental concern with safety which generated the Surety Program I am going to talk about.

To begin with, let me say that I am honored to have been selected to address this group. And, I particularly welcome this opportunity to talk to you about the U.S. Army CB Weapons Surety Program. It is a new program, and we believe that it will have a significant impact in focusing more attention on the safety, security and reliability aspects of CB weapon development, logistics, and operational deployment.

Although safety is only one aspect of the Surety Program, its impact on safety programs in general is going to be a substantial one.

The Assistant Chief of Staff for Force Development has the Department of Army staff supervision responsibility for the Surety Program, and he utilizes the US Army Nuclear Weapons Surety Group as his principal agent. The fact that I am discussing the Surety Program with you today, rather than someone from that office, is explained by the fact that the Army Materiel Command, to which I belong, has the Army mission for CB weapons development and production, and also stores all but a very small portion of the types of national stocks with which the Surety Program is concerned. Therefore, we bear the heaviest responsibilities at the operating level; and we are most directly concerned in those aspects of the Surety Program which are of primary interest to you.

As a beginning, let me define the term "surety." It is a term invented, I believe, in the Army, and we define it as follows:

> It compris... those controls, procedures, and actions contributing to the safety and security of CB weapon systems without degrading their operational performance.

The terms safety and security as used in this definition have a special significance. They are used in their broadest sense. They are not limited to the usual concepts of industrial safety, troop safety, and physical security. They include such elements as command control, reliability, stockpile sampling, fail-safe concepts, jettisoning, emergency destruction, and all other design, production and operational aspects bearing on public and user confidence in the ability of the munitions to be handled safely and securely. Weapon systems must contain the features essential to maximum operational flexibility under the constraints of an instinctive national and international prejudice against such weapons.

The CB Surety Program was established by the Department of Army last year. It is an adaptation of the highly successful Nuclear Weapons Surety Program which was established four years ago in 1964. I am usually classified as a nuclear weapons man, and as such, I am sometimes regarded rather suspiciously by old timers in the CB business. We newcomers are frequently warned against falling into the trap of over-emphasizing the similarities between CB and nuclear weapons. I would like to answer any possible challenges on that score right now by stating that we are acutely aware of the very significant differences between nuclear weapons and CB weapons, and also among the various types of CB weapons themselves. There is no tendency that I know of, either in the DA, or in our command, to force CB weapons into a pattern of regulations developed for nuclear weapons. We know that is impractical.

The point I would like to make now--and it is one which I will reiterate frequently during these remarks--is that the Surety Program is <u>not</u> a set of regulations, or standards, or criteria--and does <u>not</u> in itself impose any requirements on weapon design or logistics. As you will see, as I describe it, it is simply a management tool--<u>a method of management--for insuring that all facets of CB safety, security, reliability, control, and operational readiness are considered objectively, in their entirety, and in coordination.</u>

The reason why we think that this nuclear weapons surety management tool is applicable to CB weapons is that it is <u>very</u> evident that there <u>are</u> some basic similarities between CB and nuclear weapons, in that their use, and very existence, is complicated by psychological and emotional factors which strongly influence Government and public reaction to even minor accidents or incidents. They are all weapons of catastrophic potential--at least in the public eye. Consequently, the political, psychological, international factors take on significant and similar implications. We cannot afford even a minor incident or loss of control which might result in severe limitations on military operational flexibility. Consequently, we have the Surety Program to insure the emphasis required to prevent such incidents.

With those preliminary remarks out of the way, let me move on to a discussion of the details of the Surety Program.

The Surety Program is limited to "lethal" weapons and agents. The definition of "lethal" led to some debate; consequently, the Department of Army has published an exact listing of the weapons and agents included under the program. That listing is too long to display conveniently here, but, generally speaking, it includes all biological weapons and agents, GB, VS and similar nerve agents, BZ, phosgene and mustard.

Obviously, the problems as well as the risks associated with these different types vary widely. We recognize that. One aim of the Surety Program is to see that these different types are properly categorized, and that the controls and standards are consistent with the risks.

To achieve its objective, the Surety Program embraces the entire CB Program, from design concept to ultimate use. Just to remind you of the breadth of this scope, look at this chart. Safety, security and reliability are elements which must be designed into a system and considered throughout its life.

CB PROGRAM ELEMENTS EMBRACED BY THE SURETY PROGRAM

1. Design concept
2. Weapon design, development, and testing
3. Selection of contractors
4. Production and quality controls
5. Physical and personnel security
6. Storage
7. Transportation
8. Maintenance
9. Calibration
10. Command control
11. System reliability
12. Operational capability
13. Surveillance functions
14. Selection and training of personnel
15. Operating procedures
16. Safety rules
17. System safety
18. CB accident/incident control

Our policy is that CB surety does not exist as a separate entity but as an integral part of all CB operations. To be most effective, the Surety Program must be accomplished within the existing command and staff structure; with, however, an effective mechanism to provide the emphasis necessary to avoid complacency and routine consideration. It is not the intent of the CB Surety Program to impose an additional management structure on CB activities. Rather, the intent is to provide monitorship that will continually survey all activities related to CB weapon surety in order that surety is looked at objectively and in its entirety, and that all aspects are properly covered and coordinated.

At the Department of Army level, the Nuclear Weapons Surety Group, an independent activity, reporting directly to General Hebbeler, is the principal instrument. Very briefly summarized, they do the following:

1. They review and comment on all DA requirements and directives pertaining to any of the elements of CB surety.

2. They make frequent visits to field agencies in the CB program to monitor surety activities.

3. The group keeps a close check on all CB activities in order to assure that there are no gaps in the assignment of responsibilities, and that all responsibilities are being properly implemented by the agencies to which they are assigned.

In the field, CB surety is a command responsibility. Each commander down to the arsenal or depot level--or in the case of tactical units, down to division or separate brigade level--must appoint a Surety Officer or board to assist him in carrying out the program. The actual method of operation of the Surety Officers depends on the local command, but the objectives are as stated previously.

As an example, let me describe to you in a little more detail how we implement the CB Surety Program in the Army Materiel Command. We believe that to be fully effective at the Command level, such a program must provide three things: First, a basic document listing all regulations and directives pertaining to safety, security, reliability and operational control. I want to hasten to make it clear that this document itself is not a directive, it is simply a convenient compilation of existing guidance issued by the responsible command elements.

Second, at the command level, we feel we need an independent inspection organization to insure command wide compliance with all directives listed in the surety document. Again we have borrowed from the Nuclear Weapons Surety Program, and will use our surety field office at Dover, N. J. for this purpose. That office will eventually conduct an annual inspection of every AMC activity in the CB program. The purpose of the inspections will be to measure compliance with directives, assess the adequacy of directives, and render assistance, as necessary, for the rapid solution of problem areas which may be discovered.

This leads to the third point. To be effective any program must have teeth in it. Within the Army Materiel Command, the Commanding General, General Besson, has given me his full line authority in matters pertaining to CB surety. This gives my office the authority to step in where necessary and direct corrective actions. Naturally, this is an authority which is used sparingly. As a matter of fact, we consider it something of a management failure when we have to use it. Normally, we are able to secure the rapid response that we need utilizing the regular staff procedures. Of course, the fact that the authority exists, and the jealousy with which they regard their prerogatives, gives the staff and subordinate commands a special incentive to respond rapidly, and police their areas of responsibility carefully.

At the installation level, implementation varies somewhat; but, generally, the same three things apply: The Surety Officer must have direct access to the commander. He must have the responsibility and authority to continually review, question, and monitor all activities involving surety. He must have the authority and means of insuring coordination and corrective actions when necessary.

In depots and other logistical operations, the functions and implementation of the Surety Program is quite straight forward. However, the application of the Surety Program to R&D deserves some special mention. R&D is an especially difficult area to address. Everyone wants to get his views into every new study and design; and consequently, the R&D people often feel over-managed and hamstrung with conflicting requirements. But I believe that even here we have a very effective tool in the Surety Program, and again it is one that we borrowed from the nuclear program. We have established a group called the AMC Chemical and Biological Weapons Safety Committee to monitor the safety elements of CB weapons developments. The political and international implication of a catastrophic accident involving either chemical or biological weapons dictates the need for a continuous search for increased safety of CB weapons. This search will begin as early as practicable in the development of a system and continue throughout its life. In support of this policy, each CB weapon will be subjected to safety evaluation by the Chemical and Biological Safety Committee. The objective of the studies is to assure that CB weapons incorporate the maximum safety consistent with operational requirements. As a minimum each system will be required to satisfy the following three safety standards:

First, there will be positive measures to prevent catastrophic release of agents from weapons by means of the normal arming and firing system whenever a weapon is involved in an accident or incident or is jettisoned, and all practicable measures permitted by tactical requirements to prevent release by any other means.

Second, there will be positive measures to prevent inadvertent arming, launching, or firing.

Third, there will be positive measures to aid commanders in prevention of deliberate unauthorized arming, launching, or firing.

This committee will study each weapon design in relation to the three safety standards, the stockpile-to-target sequence, and the operational concept, at least twice during the development program.

The initial safety study will be conducted not later than 90 days before design release to production. The primary purpose of this study is to identify as early as practicable in the development cycle, deficiencies with respect to safety, and to provide guidance for further development that may be required to enable the system to meet the safety standards. The study will consist of detailed examination of design features, material, procedures, and operational concepts available at the time of the study that will effect the weapon's safety throughout its life.

The preoperational safety study will be conducted along the same lines approximately 90 days prior to initial availability in stockpile. Special safety studies will be conducted at any time deemed necessary during the life of the system to evaluate:

1. Unsafe conditions revealed by operational experience.
2. Modifications, alterations, and retrofits that may affect safety.
3. Procedural changes that may affect safety.

The safety committee has no authority to enforce its recommendations, and therefore does not infringe on the responsibilities of any development agency. However, it is obvious that no weapon system is going to be deployed or produced until the recommendations of the committee are satisfactorily answered. The committee is now active. We are also planning to have it review certain systems already in stock to ascertain if we have any undiscovered surety problems which require attention.

I have just had occasion to review the first study and recommendations on three weapon systems now in stock. I have been highly impressed. The recommendations are sound. Some weaknesses have been exposed. Corrective action is going to be taken. To set your mind at ease, I should mention that these weaknesses are not serious, and that the actions we are taking are more in the nature of enhancing an already high level of safety. But this is exactly the type of thing we want to do.

It is evident to you now that a great deal of the Surety Program is involved in enforcing compliance with directives. But the program will not be a real success if it does not also stimulate a great deal of new thinking and progress in both the areas of weapon system design and tactical/logistical concepts. Obviously, the ideal way of handling surety problems is to design safety and reliability into a system, rather than depend on procedural controls.

The fact that nuclear weapons are deployed far forward in overseas commands, and are maintained on alert in anti-aircraft defenses, missile sites, and on patrolling aircraft and naval vessels, has forced nuclear weapon system designers to face up sharply to peacetime safety and reliability considerations. Our Government's policy with respect to the military services in the case of peacetime deployment of nuclear weapon systems has been clear. The operational flexibility they give us is limited by the extent that we can prove to them the inherent peacetime design safety of our weapon systems and procedures, and describe to them precisely what risk they are taking. This has forced the nuclear weapon system designer to give safety and reliability very high priority among competing military characteristics.

I infer that, to a great extent, the Services have assumed that lethal CB weapons will be subject to very limited deployment in peacetime; and that, therefore, consideration of surety has been largely concentrated on conditions in depot storage and on the wartime battlefield, with much less consideration given to the large spectrum of possible conditions of deployment in between. Whether this inference is right or wrong may be debatable. But I am sure of a number of things:

First, that a careful review of nuclear surety philosophy and design features as they pertain to such things as emergency destruction, self-destruction, jettisoning, and fail-safe can be very profitable for the CB community.

Second, that it may be possible, at acceptable cost, to build into certain CB weapon systems additional flexibility for peacetime or limited war deployment which may prove invaluable.

Third, that, in any event, before a national policy decision is made, even in wartime, to use lethal CB weapons, very searching questions (similar to those that have been asked about nuclear weapons) are going to be asked about the surety features of CB weapons, particularly from the design standpoint.

We have found that trying to convince people in the Government that nuclear weapons are really not so dangerous after all, --or playing up our accident free record, --is really not very effective in attempting to get more operational flexibility. To be quite frank, it is a waste of breath. It is also becoming more and more evident that in matters of this type they place only limited faith in personal responsibility or judgment at any level of command. This is sad, but also true.

The things that convince them most are inherently safe systems that are designed to cope with any possible circumstances, --and detailed analyses that allow them to evaluate every possible risk. Both industry and our arsenals must, in my opinion, give a great deal more imaginative thought to surety in design.

Now to conclude, let me answer a rhetorical question: "How far have we actually gone in implementing this new CB Surety Program?" After a start late last fall, the following has been accomplished: Directives have been published. Surety officers have been appointed. The basic surety document which compiles all applicable directives is due for publication this summer. Personnel spaces have been authorized to augment our Surety Field Office (i.e., our inspection arm) and recruitment is underway. The Field Office has made preliminary visits to most of the CB field installations in the command, and is preparing SOP's for inspections. Inspections will start on a limited basis in this fiscal year. The CB Safety Committee has completed studies on four weapon systems. My office is already becoming active in seeing that AMC regulations pertaining to CB weapons safety, security and reliability are updated and expanded as necessary. We are adding another man to our staff.

This isn't the type of rapid progress we want. The war in SEA and limitations on resources makes the implementation painfully slow. But we are underway.

Gentlemen: That is our program. Let me emphasize again that the CB Surety Program is a management tool, and does not in itself impose any requirements on the CB Weapons Program. Its purpose is to insure that all directives pertaining to safety, security and reliability and operational readiness are properly carried out, and that coverage is complete and that responsibilities are properly assigned. Although we are only now getting started, I believe that on the basis of the four year old Nuclear Weapons Surety Program, we can safely predict that it will be an effective management tool and will ultimately result in improved operational readiness and flexibility.

SIMULTANEITY OF EXPLOSIONS -- WHERE AND WHEN

by

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This paper relates to recent concern about the assumptions of the so-called Simultaneity Rule for storage of high explosives. The rule allows the quantity-distance tables to be applied on the basis of the weight of high explosive in just one unit of a multi-unit storage complex. It presupposes that if one unit detonates, propagation to other units is delayed and that, as a result, the blasts are sequential rather than additive. The wave is thus presumed to consist of a series of peaks whose amplitude is no greater than that from one unit. From this, it is clear that the term "Simultaneity Rule" is a misnomer, since, in fact, it presupposes nonsimultaneity. It assumes that the explosion shock from several sequential explosions do not coalesce.

It is no reflection on the early intuitive origins of the simultaneity rule to say that our present general understanding of blast wave phenomena, supported by several specific recent measurements of blast waves from sequential explosions, indicates that shock wave coalescence does occur for a surprisingly wide range of conditions, including those in typical multistorage facilities. In what follows, we will see where one shock front is located when a second explosion occurs later in time, and at some distance from the first. This will lead to consideration of various types of shock interactions. Knowledge of these interactions will determine where such multiple shocks coalesce, and should control how we apply the quantity-distance tables.

The comments here, however, do not bear on the question: "Under what conditions will a second unit detonate?" That is a matter of sensitivity in order for propagation of explosion from one unit to the next to occur. But if propagation to a second unit does occur -- and this is all the simultaneity rule is also concerned with -- if a second unit goes, how do the two blast waves interact?

So far as the dividing wall itself is concerned, it affects sensitivity to propagation. It also affects the time delay to the second detonation. But, again, the comments here will not be concerned with how time delays occur -- whether due to type of weapon, intervening distance or materials -- but only with the effect on the blast wave of various assumed time delays.

Let's first consider the circumstances in the large scale simultaneity tests recently conducted at China Lake. Two 5,000-lb charges located 14 feet apart center to center were fired with a deliberate 24 millisecond time separation between the first and second shot (Figure 1). In spite of the large distance beyond the second charge that the shock front from the first charge had moved, as shown in the illustration, pressure-time histories of the shock waves showed that the shock from the second charge caught up and coalesced with the first shock. Furthermore, the combined front had the strength of one charge of combined weight.

This result was predicted in a small scale test series conducted by URS Corporation for DASA in anticipation of the large scale NWC tests. (Mr. Kenneth Kaplan who chaired one of the specialist sessions at the meeting was responsible for that effort.) The tests were done on about a 1/27 linear dimension scale with 1/4-lb charges. Such excellent correlation of results shows the utility of extensive small scale tests before large sums are spent on rearranging China Lake topography. Small scale tests permit many shots over a wide range of variables to be fired quickly and inexpensively.

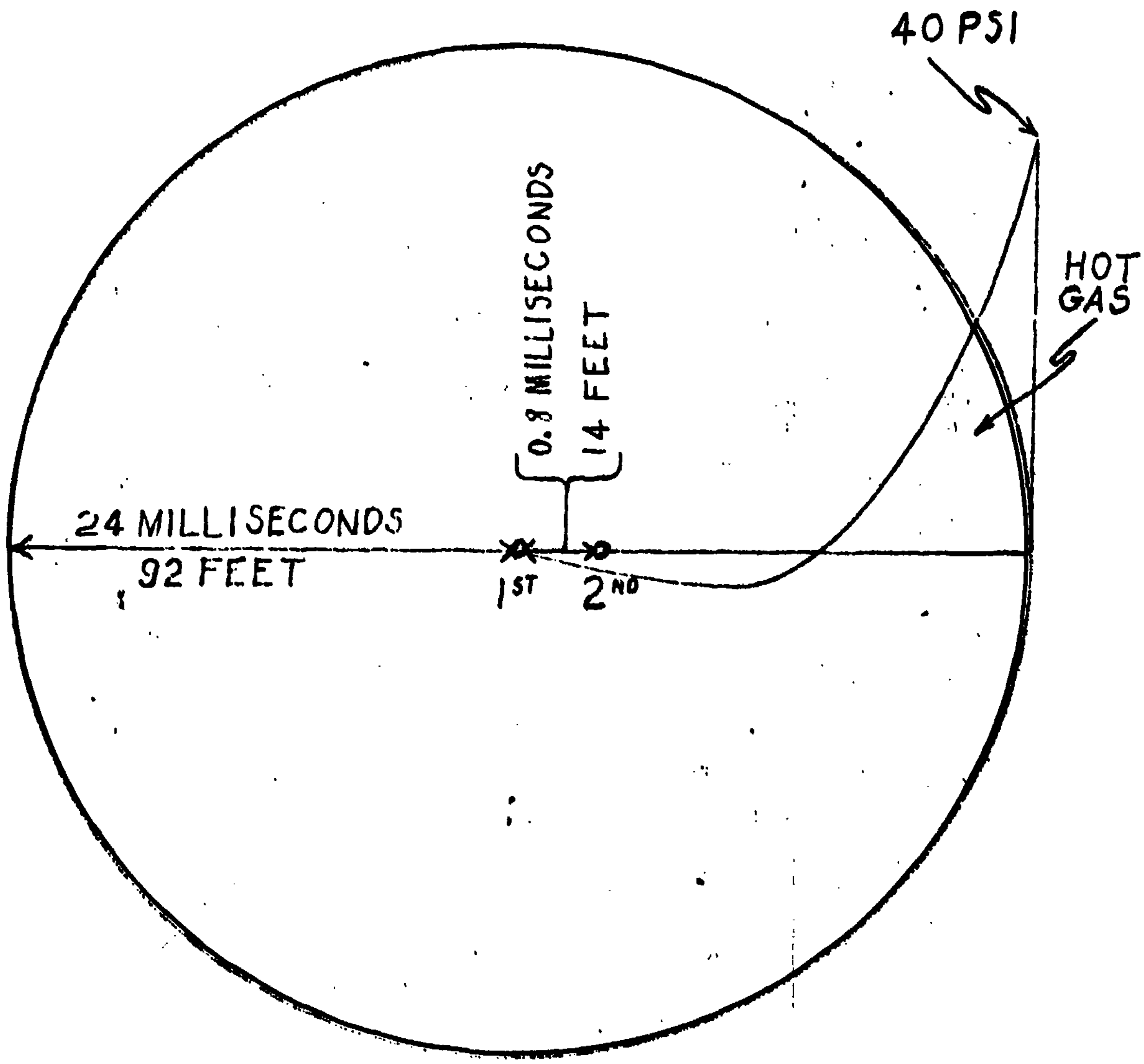
To return to our problem: we may ask "how did this coalescence of shock waves occur?" The first shock wave is down to a speed of about 2000 feet per second when the second explosion starts out as a detonation wave moving at 20,000 feet per second. The second front slows down very fast, but when it reaches the heated gas of the positive phase of the first wave (see Figure 1, superposed pressure-distance curve) it speeds up. The closer the second shock front gets to the front of the first shock the hotter the gas medium in which it travels and the faster the second front moves. When the two have joined the strengthened single shock moves out at a new higher velocity related to the higher pressure of the coalesced wave.

While many features were typical of real cases, the time of 24 milliseconds used in the China Lake test was clearly artificial. It is very much larger than the time delay to be expected in any realistic case. This was done in order, it was thought, to give maximum validity to the test. It actually takes less than one millisecond for the shock wave from a 5000-lb surface detonation to travel 14 feet from its center. In some circumstances fragments might reach a second charge and start detonation before the shock wave from the first arrived.

In such cases, where the second charge detonates before or near the time of arrival of the first shock, we have a different type of interaction (Figure 2). Here the two shocks reflect off one another. The reflection progressively catches up with the direct wave. The coalesced or joined region is the well known Mach shock. As it occurs here, it is identical to the case of an explosion in air above a rigid surface where the shock is reflected at the surface. The rigid surface corresponds in Figure 2 to the imaginary plane bisecting our two charge array. In the illustration we showed two similar shots fired simultaneously. If a small time delay were introduced the plane of reflection would be shifted in the direction of the second explosion and would become a curved surface.

The two cases described here, *first*, the explosion within an explosion, with catch-up occurring from behind; and second, the head-on collision with coalescence occurring by Mach wave formation -- these two physical models, I believe, provide the basis for analyzing sequential explosions. By calculation of the hydrodynamics by hand, by digital computer or both, and by doing some judicious small scale experiments, we can determine whether coalescence of the shock waves from two chronologically and spatially separate explosions has occurred at magazine and interline as well as inhabited building distances (where this has already been established) and whether coalescence has occurred in all directions. These calculations may be necessary for each class or type of facility. On the other hand, it may turn out that a conservative basis will be found to make possible one general rule for all cases. This would occur if we can settle on an upper limit for the distance and time between two charge detonations.

Finally, we must act on the results. If we know that the shock waves from a series of explosions, while they are still strong enough to do damage, coalesce into one shock whose strength approximately equals that to be expected from the total amount of explosive detonated as one mass, then we face two alternatives. Either we must insure that a detonation of one unit will not propagate to another unit or provide the necessary distance required by the quantity-distance tables for the total amount to be stored in a complex.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HOT GAS
0.8 MILLISECONDS
14 FEET
24 MILLISECONDS
92 FEET
1ST
2ND

Figure 1

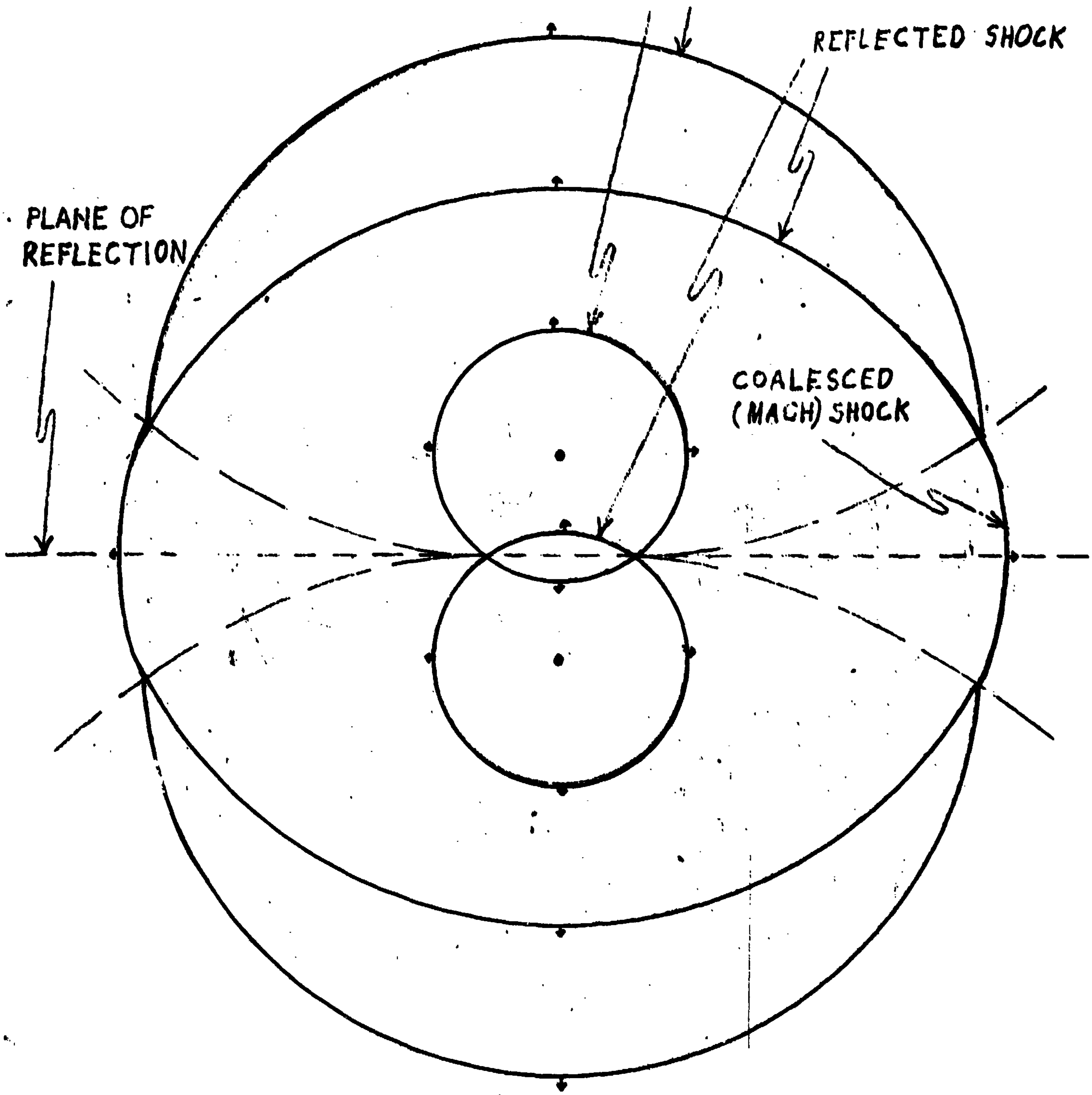

Figure 2

A LOOK AT EXPLOSIVE SAFETY FROM THE R&D VIEWPOINT

by

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Eglin Air Force Base, Florida

(U) The people who develop, test, and evaluate new explosive items have to be concerned with many requirements, including safety. They are also concerned with safety from several different angles.

(U) First, let us consider some of the requirements and goals for new munitions.

(U) They must be as effective as possible; have a high probability of kill (P_K). Considerable effort is expended in determining munition effectiveness, and some of the test data is useful to the safety people since munitions are themselves vulnerable in varying degrees to the same kill mechanisms that they produce, i.e., blast, fragments, projectile and shaped charge penetration, underwater shock, flame and incendiary effects.

(U) They must be as reliable as possible. They must be safe. They should create a minimum of logistic problems. Here the accepted explosive safety principles of separating different components of some complete rounds add to logistic problems of packaging, shipment, storage, and bookkeeping.

(U) They must be compatible with delivery systems, whether they be man, land vehicle, ship, aircraft, or missile. The greatest problem here is with the aircraft. If you tried to make every air munition compatible with every station on every aircraft in every combination of mixed loads, you run into literally millions of combinations.

(U) The ingenuity of the VC in reusing our dud ordnance in SEA has forced a greater emphasis on design features, such as antitamper, self-destruct, self-sterilization and other techniques.

(U) The development engineer is concerned with explosive safety from several aspects, not only with manufacturing, shipping and storage but with safety in testing, training use and combat use.

(U) Since R&D is concerned with safety in the entire stockpile to target sequence, the people who develop and test explosive munitions have to be concerned with environment, human factors, vulnerability, delivery considerations, and E.O.D. and render safe procedures.

(U) In the environmental area, he has to design and test for resistance to the natural environmental factors of temperature, sunshine, altitude, moisture, fungus, salt air, sand and dust. He also has to worry about the man-made environments, such as vibration, acoustics, EMR, and aerodynamic heating.

(U) As to human factors, the skill levels and any extra training required for the people who will use the item have to be considered. The safety precautions have to be put into the technical data (Technical Orders, Manuals, etc.) at every step where they are required. In addition, he should use all his ability to design around Murphy's Law which says, in effect, that if there is any possible way to do something wrong, somebody will eventually do it.

(U) As to delivery considerations, the requirement for a reliable safing and arming device is always with us except for the most simple weapons. In addition, safe escape distance is quite often a matter of life and death when the man delivering a weapon finds himself too close to his target when it functions. Although this term was probably coined in connection with air delivery of nuclear weapons, the same thing has existed with HE bombs, depth charges and hand grenades for a long time.

(U) Vulnerability to accidents and enemy action has to be one of the factors in design and development.

(U) Although there are obvious practical design limits to making an explosive item invulnerable, some effort is necessary. It makes little sense, for example, to spend thousands of dollars to provide armor and other items to reduce the vulnerability of a five-million dollar aircraft, then load it with six-hundred dollar munitions which will go high order from one caliber .30 bullet.

(U) Since it is impossible to make an explosive item completely invulnerable to fires, accidents, and enemy action, tests such as cook-off and bullet impact are conducted to determine sensitivity.

(U) Finally, the developer has to insure that Render Safe Procedures are developed so that Explosive Ordnance Disposal personnel can perform their job when necessary.

(U) Let's look at some trends in R&D which may affect safety.

(U) In the new explosive area, the Air Force is looking at some of the liquid explosives, such as astrolite A-1-5 and IRECO slurries. We also have one munition in which two liquids are mixed inside the item during the arming process, thus forming an explosive.

(C) The Navy is working on a so-called COAX explosive which has a core of high energy, low detonation velocity explosive, such as ammonium nitrate and aluminum, and an outer layer of high detonation velocity explosive. They are also looking at new high energy compositions with low shock sensitivity to replace Explosive D (ammonium picrate) in AP projectiles. One of these is a mixture of RDX and aluminum in a matrix of nitrated polymer.

(C) Both the Navy and Air Force are developing fuel/air explosive munitions using fuels such as ethylene oxide and liquid hydrocarbons.

(U) The Air Force has one program to investigate new high energy, low flame temperature propellants for gun ammunition, including some of the liquid and gelled rocket propellants.

(U) There is trend toward multipurpose items; combinations of several functions in the same item. One example is the FMU-26/B bomb fuze which was designed to provide function at any one of several short delay times, medium delay times, and cluster airburst times from 4 to 90 seconds; over 200 combinations. Several other interdiction type munitions include sophisticated target sensing devices, antitamper features, self-sterilization and self-destruct devices.

(U) The trend away from relatively simple mechanical fuzing toward more complex electrical and electronic fuzing systems sometimes aggravates safety problems, such as the possibility of moisture causing a short circuit.

(U) Some of the more exotic safe and arm methods have potential safety problems. LTC Fischer will cover this in a short briefing.

(U) Although we have had cluster bombs and warheads for many years, the trend continues to smaller items, from grapefruit size to tennis ball size to golf ball size - even to the size of a grape. Each item is an explosive round complete with fuze, and the cluster shell is inherently less strong than a conventional bomb; therefore, there are potentially more problems with handling and shipping and with E.O.D. in case of an explosive accident.

(U) Lately there has been some indication that effectiveness against some targets is enhanced by a combination of fragmentation and incendiary munitions which can be combined in the same cluster or dispenser.

(U) High explosive is being added to napalm bombs in an effort to improve flame fuel dissemination characteristics.

(U) Because of the need for shorter turn-around time in launching air strikes, pre-assembly and fuzing of bombs and preloading of multiple bomb racks are being considered by the Air Force.

(C) The Navy is also developing an advanced general purpose bomb with integral fuze and fins.

(U) In conclusion, let us say that explosive safety is, in no small measure, dependent on how well the development engineer does his job.

NEW R&D EXPLOSIVE ITEMS WHICH MAY AGGRAVATE EXPLOSIVES SAFETY PROBLEMS

by

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(U) The theme of this Seminar session concerns new explosive items that may increase explosives safety problems. In line with this topic, I'll briefly discuss a program wherein the Army developed a family of mines which were subsequently adopted for Air Force use. These mines, together with their associated dispensing mechanisms, are nicknamed Low Speed Gravel and, as this implies, are for use in the speed range of 150K - 300K.

(U) The Low Speed Gravel munitions consist of a four-tube dispenser, loaded with one of two basic mine designs; one is termed Gravel, the other is termed the Button Bomb. Both of these mines (Gravel) contain the same basic ingredients, but in different ratios; the Button Bomb contains different ingredients.

(C) The ingredients of both Gravel and Micro-gravel are: RDX which is the main explosive; a more sensitive ingredient is lead azide for use as a booster; and the initiator is ground glass, which provides friction. The ingredients of the Button Bomb are: potassium chlorate which is the main explosive; a mix of red phosphorous and magnesium oxide for use as a booster; and the initiator is silica gel, which provides friction. As I've said, friction is the initiator, and this is supplied whenever pressure is placed on the mine. Detonation will occur when these mines are stepped on, or when a truck tire runs over them, or in other similar manner.

(C) The safety problems associated with these mines stem from two basic causes: first, the mine is always in an armed condition; second, these combinations of ingredients form very sensitive explosive items. These items are so sensitive that they must be desensitized to allow safe loading, handling, packaging, transportation, storage, and aircraft carriage and delivery.

(C) The desensitizing of these mines is achieved in two steps. Each mine design also contains, as a basic ingredient, a desensitizer called cab-o-sill. The mines are also immersed in liquid freon. The combination of the cab-o-sill and the liquid freon produces an inert mine which does not become "live," so-to-speak, until the freon dries from the mine.

(C) These mines are loaded into canisters, which are long cylindrical tubes about 5" in diameter; four canisters are loaded into the dispenser. Each canister consists of the following: an external tube which is sealed and pressurized with nitrogen at about 50 p.s.i.g.; an inner tube, or anulus, contains the mines, together with the liquid freon. The inner tube is sealed, on the aft end, by a metal disc and "O" ring; it is sealed on the other end by a piston attached to another metal disc and "O" ring; the piston is used to expel the mines from the tube after the aft end is opened. The pressurized nitrogen drives the piston rearward, to expel the mines.

(C) We must continually monitor these munitions in order that proper disposal procedures may be initiated as soon as we suspect the existence of overly sensitive mines. Basically, the monitoring equipment measures the nitrogen pressure (which should be at 50 p.s.i.g.), the loss of which, indicates canister leakage and probable loss of liquid freon. If the pressure decreases to about 33 p.s.i.g., it is assumed that sufficient freon has escaped to allow the mines to become unacceptably sensitive and the suspect munitions are promptly submitted to EOD procedures. Two different monitoring methods are available. One is an electrical device that works through a pressure switch on the canister, and which emits an audible and visual signal when the pressure is too low. The other is a simple pressure gauge which reads in the "inoperable" zone when the pressure is too low. Both monitoring devices are used during transportation and storage. The electrical monitoring equipment is connected to the delivery aircraft's weapons monitoring circuit for combat delivery against the enemy. If, during combat flight, the canister pressure drops to 33 p.s.i.g., the pilot is warned of this and he will jettison the dispenser with the suspect canister. If this pressure loss occurs during transportation or storage, EOD personnel will render the suspect munitions safe by established procedures.

(C) These mines have been proven to become more sensitive after exposure to: elevated temperatures, in the range of about 90° - 135°F; vibration, as would be experienced in transportation and aircraft carriage; and in combination of these two environments. In addition, Quality Control, in manufacture of these mines, has been proven to be important. Close quality control is required to assure the proper control of percentages of the various ingredients, especially the desensitizer, cab-o-sill, which I previously mentioned, and also, the level of freon in the canister. Basically, the greater the cab-o-sill content, the less sensitive is the mine; the reverse is true for lower cab-o-sill content.

(U) From a safety viewpoint, therefore, the introduction of munitions incorporating these types of explosives, resulted in a need for very close monitoring of various aspects of these munitions, from the point of manufacture to the point of delivery against an enemy.

(C) First, adequate quality controls procedures must be instituted during manufacture of these mines to assure control of proper percentages of ingredients, especially the cab-o-sill desensitizer and the amount of freon that is put into the mine-loaded canisters.

(C) The loaded canisters must be continuously monitored, to insure proper nitrogen pressurization which indicates leakage and possible freon loss, throughout the life of these munitions; that is, during handling, transportation, storage, and actual delivery on target. In the event low pressures are indicated for any canisters, these canisters must be disposed of since we must assume that freon leakage has occurred, with possible attendant increased mine sensitivity. Care must be taken, by munitions personnel, to insure that these dispensers are not stored in direct sunlight because of mine sensitivity to the higher temperatures. If the munitions had been stored in direct sunlight, these munitions must be removed to a shaded site and held there for at least four hours, prior to being loaded on the fighter/bomber aircraft.

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DDESB-KMC

0 7 JUL 2000

MEMORANDUM FOR DDESB RECORDS

SUBJECT: Declassification of Explosives Safety Seminar Minutes

References: (a) Department of Defense 5200.1-R Information Security Program, 14 Jan 1997

(b) Executive Order 12958, 14 October 1995 Classified National Security Information

In accordance with reference (a) and (b) downgrading of information to a lower level of classification is appropriate when the information no longer requires protection at the originally level, therefore the following DoD Explosives Safety Seminar minutes are declassified:

a. AD#335188 Minutes from Seminar held 10-11 June 1959.
b. AD#332709 Minutes from Seminar held 12-14 July 1960.
c. AD#332711 Minutes from Seminar held 8-10 August 1961.
d. AD#332710 Minutes from Seminar held 7-9 August 1962.
e. AD#346196 Minutes from Seminar held 20-22 August 1963.
f. AD#456999 Minutes from Seminar held 18-20 August 1964.
g. AD#368108 Minutes from Seminar held 24-26 August 1965.
h. AD#801103 Minutes from Seminar held 9-11 August 1966.
i. AD#824044 Minutes from Seminar held 15-17 August 1967.
j. AD#846612 and AD#394775 Minutes from Seminar held 13-15 August 1968.
k. AD#862868 and AD#861893 Minutes from Seminar held 9-10 September 1969.

The DoD Explosives Safety Seminar minutes listed above are considered to be public release, distribution unlimited.

DANIEL T. TOMPKINS
Colonel, USAF
Chairman

Attachments:
1. Cover pages of minutes

cc:
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Phone call from DDC, 1500 hours, 29 June 1979, stated this document is now UNCLASSIFIED.

B. J. MAST

SHERATON HOTEL

Louisville, Kentucky

13-15 August 1968

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